Marine Sponges: Chemicobiological and Biomedical Applications

Ramjee Pallela • Hermann Ehrlich
Editors

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Springer

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ISBN 978-81-322-2792-2 ISBN 978-81-322-2794-6 (eBook)
DOI 10.1007/978-81-322-2794-6

Library of Congress Control Number: 2016947950

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Printed on acid-free paper

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Preface

Sponges (phylum Porifera) are probably one of the earliest branching animals and their fossil record dates back to the Precambrian. These simply organized, exclusively aquatic and almost sessile organisms habituate in both fresh and marine waters. According to the modern view, the divisions of sponges include four classes: Demospongiae (horn sponges), Hexactinellida (glass sponges), Calcarea (calcareous sponges) and Homoscleromorpha (for details see World Porifera database. Available: <http://www.marinespecies.org/>). Over million years of evolution, sponges developed a unique strategy for survival via their attachment to hard substrates, and consequently, being open to all possible predators including microorganisms and metazoans. They contain mechanically stable, usually mineralized skeletons, and possess the ability to synthesize secondary metabolites with antiviral, antibacterial, antifungal and cytotoxic activities.

Biomimnology of diverse sponges skeletal structures like biosilica- and calcite-based spicules is well investigated and represents a source for bioinspired materials science today. The organic chemistry of the same structures is also of immense scientific interest due to the presence of very special biopolymers including collagens, chitin, keratin-like sponging, as well as a broad variety of proteins with enzymatic activities. Some of them, for example, silicateins, are involved in biosilicification. Although there has been tremendous activity within numerous scientific groups to obtain better understanding of the structural biology of the biomineralization phenomenon in sponges, a detailed knowledge of the genetic, biochemical and molecular mechanisms involved is still lacking. Even recent discoveries on highly hydroxylated collagen in anchoring spicules of glass sponges, and chitin within skeletal fibrous networks of some keratose demosponges, produced more open questions than answers. Both the mechanical and optical properties of selected spicular structures observed in some sponges have attracted the attention of experts from such scientific fields as biomimetics, bionics and biophotonics. Spongin- and chitin-based three-dimensional scaffolds isolated from demosponges possess high biomimetic potential for biomedicine and tissue engineering.

Due to their excellently developed strategy of chemical defense, sponges (mostly demosponges) are important within the fields of marine biotechnology and marine pharmacology. Moreover, they are considered as the best resources for highly active therapeutic molecules amongst other marine

invertebrates. Several biological compounds isolated from marine sponges have been further explored for pharmaceutical drug development. Ara-C is the first isolated compound for cancer treatment that is used widely. Usually, sponges synthesize different substances with antibiotic activity simultaneously by themselves (Verongida sponges), or due to their symbiotic microorganisms. Consequently, they represent intriguing examples for experts which are involved in research on multidrug-resistant organisms.

Various experts in marine sponge related area globally have contributed valuable chapters in the present book. We strongly believe that this would provide enough insights into the amazing world of marine sponges to the readers. The present book is an attempt to compile the novel information available on sponge metabolites, including low molecular weight bioactive compounds, and structural biopolymers and their isolation techniques as well as the biomedical applications at the same place. It is an essential reading for the novice and expert in the field of marine biotechnology and pharmacology, natural product researchers and chemists, industrialists as well as students.

Hyderabad, India

Ramjee Pallela

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About the Editors

Dr. Ramjee Pallela, Ph.D., M.B.A. is currently working as a chief manager at IKP Knowledge Park (IKP), Hyderabad, India. His career at IKP has involved igniting scientific brains through meetings and personal interactions, inspiring proposals for start-up grants and mediating the process with Biotechnology Industry Research Assistance Council (BIRAC) through IKP. Before his engagement with IKP, Dr. Pallela served as research scientist at the International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi, India. With a Ph.D. from Osmania University [CSIR-IICT as pedestal workstation], India, Dr. Pallela has engaged into biomedical research during his postdoctoral stay at South Korea spanning from 2009 to 2012. He started working towards transplanting his scientific acumen into management roles with a P.G. diploma in patent law from the National Academy of Legal Studies and Research (NALSAR) University of Law, Hyderabad, and with an M.B.A. degree from Pondicherry University, India. Accolades for his scientific excellence are marked with more than 40 research publications in varied national and international journals/books, which are majorly related to toxicology, marine sponge biology, and development of novel biopolymer scaffolds and their applications in bone tissue engineering.

Hermann Ehrlich, Prof. Dr. rer. nat. habil (1957) after the defense of the Ph.D. thesis (1984) served as a postdoctoral researcher at Max Bergmann Center of Biomaterials and Institute of Materials Science in Dresden. After successful habilitation in 2011 at Christian-Albrechts University in Kiel, he holds a W3 Heisenberg full professor position at the Institute of Experimental Physics at the TU Bergakademie Freiberg. His research is focused on marine biomaterials, biominerals, biocomposites, and biomimetics. Using biochemical, cellular, molecular, and analytical approaches, he and his coworkers, for the first time, discovered and characterized chitin and novel hydroxylated collagen in the skeletal

formations of marine sponges. During last 10 years, he has published over 70 peer-reviewed articles, 8 book chapters, and 2 monographs and is additionally holding 4 patents.

He represented numerous invited and keynote lectures at Columbia University, at Yale University, and at the Massachusetts Institute of Technology as well. Recently, H. Ehrlich has been nominated for the Gottfried Wilhelm Leibniz Prize 2015.